CLAIMS

1. An apparatus comprising:

at least one first arrangement providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a non-reflective reference, wherein a frequency of radiation provided by the at least one first arrangement varies over time; and

at least one second arrangement detecting an interference between at least one third radiation associated with the at least one first radiation and at least one fourth radiation associated with the at least one second radiation.

2. The apparatus according to claim 1, wherein the at least one third radiation is a radiation returned from the sample, and the at least one fourth radiation is a radiation returned from the reference.

3. The apparatus according to claim 1, further comprising at least one third arrangement for shifting the frequency of at least one of the at least one first electro-magnetic radiation, the at least one second electromagnetic radiation, the at least one third electro-magnetic radiation and the at least one third electro-magnetic radiation.

4. The apparatus according to claim 1, further comprising at least one third arrangement generating an image based on the detected interference.

5. The apparatus according to claim 4, further comprising a probe which scans a transverse location of the sample to generate scanning data, and which provides the scanning data to the third arrangement so as to generate the image.

6. The apparatus according to claim 5, wherein the scanning data includes the detected interference obtained at multiple transverse locations on the sample.

7. The apparatus according to claim 1, wherein at least one second arrangement comprises at least one photodetector and at least one electrical filter which follows the at least one photodetector.

8. The apparatus according to claim 3, wherein at least one second arrangement comprises at least one photodetector and at least one electrical filter which follows the at least one photodetector.

9. The apparatus according to claim 8, wherein the at least one electric filter is a bandpass filter having a center frequency that is approximately the same as a magnitude of the frequency shift by the frequency shifting arrangement.

10. The apparatus according to claim 9, wherein a transmission profile of the electrical filter varies substantially over its passband.

11. The apparatus according to claim 5, wherein the probe comprises a rotary junction and a fiber-optic catheter.

12. The apparatus according to claim 11, wherein the catheter is rotated at a speed higher than 30 revolutions per second.

13. The apparatus according to claim 1, further comprising at least one polarization modulator.

14. The apparatus according to claim 1, wherein the at least one second arrangement is capable of detecting a polarization state of at least one of the first and second electromagnetic radiation.

15. The apparatus according to claim 1, wherein the at least one second arrangement comprises at least one dual balanced receiver.

16. The apparatus according to claim 1, wherein the at least one second arrangement comprises at least one polarization diverse receiver.

17. The apparatus according to claim 1, wherein the at least one second arrangement comprises at least one polarization diverse and dual balanced receiver.

18. The apparatus according to claim 1, further comprising at least one third arrangement for tracking the phase difference between at least one of:

- the at least one first electromagnetic radiation and the at least one second electromagnetic radiation, and
- the at least one third electromagnetic radiation and the at least one fourth electromagnetic radiation.

19. The apparatus according to claim 1, further comprising an arrangement emitting the first and second electro-magnetic radiations at least one of which has a spectrum whose mean frequency changes substantially continuously over time at a tuning speed that is greater than 100 Tera Hertz per millisecond.

20. A method comprising the steps of:

providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a non-reflective reference, wherein a frequency of the at least one of the first and second radiations varies over time; and

detecting an interference between at least one third radiation associated with the at least one first radiation and at least one fourth radiation associated with the at least one second radiation.

21. An apparatus comprising:

at least one first arrangement providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a reference, wherein at least one of the first and second electro-magnetic radiations has a spectrum which changes over time, the spectrum containing multiple frequencies at a particular time; and

at least one second arrangement detecting an interference between at least one third radiation associated with the at least one first radiation and at least one fourth radiation associated with the at least one second radiation.

22. The apparatus according to claim 21, wherein the at least one third radiation is a radiation returned from the sample, and the at least one fourth radiation is a radiation returned from the reference.

23. The apparatus according to claim 21, further comprising at least one third arrangement for shifting the frequencies of at least one of the at least one first electro-magnetic radiation, the at least one second electromagnetic radiation, the at least one third electro-magnetic radiation and the at least one fourth electromagnetic radiation.

24. The apparatus according to claim 21, further comprising at least one third arrangement generating an image based on the detected interference.

25. The apparatus according to claim 24, further comprising a probe which scans a transverse location of the sample to generate scanning data, and which provides the scanning data to the third arrangement so as to generate the image.

26. The apparatus according to claim 25, wherein the scanning data includes the detected interference obtained at multiple transverse locations on the sample.

27. The apparatus according to claim 21, wherein the reference is non-reflective.

28. The apparatus according to claim 21, wherein a median of the spectrum varies substantially linearly over time.

29. The apparatus according to claim 28, wherein a rate of change of the median of the spectrum is at least 1000nm/msec.

30. The apparatus according to claim 21, wherein the spectrum change over time repetitively with a repetition rate of at least 10 kHz.

31. The apparatus according to claim 21, wherein the at least one first arrangement includes a spectral filter to vary the spectrum over time.

32. The apparatus according to claim 31, wherein the spectral filter includes a polygon scanner and a spectral separating arrangement that vary the spectrum over time.

33. The apparatus according to claim 21, wherein the at least one first arrangement includes a semiconductor gain medium at least one of generating and amplifying an electro-magnetic radiation.

34. The apparatus according to claim 23, wherein at least one second arrangement comprises at least one photodetector and at least one electrical filter which follows the at least one photodetector.

35. The apparatus according to claim 34, wherein the at least one electric filter is a bandpass filter having a center frequency that is approximately the same as a magnitude of the frequency shift by the frequency shifting arrangement.

36. The apparatus according to claim 35, wherein a transmission profile of the electrical filter varies substantially over its passband.

37. The apparatus according to claim 25, wherein the probe comprises a rotary junction and a fiber-optic catheter.

38. The apparatus according to claim 37, wherein the catheter is rotated at a speed higher than 30 revolutions per second.

39. The apparatus according to claim 21, further comprising at least one polarization modulator.

40. The apparatus according to claim 21, wherein the at least one second arrangement is capable of detecting a polarization state of at least one of the first and second electromagnetic radiation.

41. The apparatus according to claim 21, wherein the at least one second arrangement comprises at least one dual balanced receiver.

42. The apparatus according to claim 21, wherein the at least one second arrangement comprises at least one polarization diverse receiver.

43. The apparatus according to claim 21, wherein the at least one second arrangement comprises at least one polarization diverse and dual balanced receiver.

44. The apparatus according to claim 21, further comprising at least one third arrangement for tracking the phase difference between at least one of:

- the at least one first electromagnetic radiation and the at least one second electromagnetic radiation, and
- the at least one third electromagnetic radiation and the at least one fourth electromagnetic radiation.

45. A method comprising the steps of:

providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a reference, wherein at least one of the first and second electro-magnetic radiation has a spectrum which changes over time, the spectrum containing multiple frequencies at a particular time; and

detecting an interference between at least one third radiation associated with the at least one first radiation and at least one fourth radiation associated with the at least one second radiation.

46. An apparatus comprising:

at least one first arrangement providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a reference, wherein a frequency of radiation provided by the at least one first arrangement varies over time;

at least one second arrangement detecting a first interference signal between at least one third radiation associated with the at least one first radiation and at least one

fourth radiation associated with the at least one second radiation in a first polarization state; and

at least one third arrangement detecting a second interference signal between the third and fourth electro-magnetic radiations in a second polarization state, wherein the first and second polarization states being different from one another.

47. The apparatus according to claim 46, wherein the at least one third radiation is a radiation returned from the sample, and the at least one fourth radiation is a radiation returned from the reference.

48. The apparatus according to claim 46, further comprising at least one fourth arrangement configured to shift the frequency of at least one of the at least one first electro-magnetic radiation, the at least one second electromagnetic radiation, the at least one third electro-magnetic radiation and the at least one fourth electro-magnetic radiation.

49. The apparatus according to claim 46, further comprising at least one fourth arrangement generating an image based on the detected interference.

50. The apparatus according to claim 49, further comprising a probe which scans a transverse location of the sample to generate scanning data, and which provides the scanning data to the fourth arrangement so as to generate the image.

51. The apparatus according to claim 50, wherein the scanning data includes the detected interference obtained at multiple transverse locations on the sample.

52. The apparatus according to claim 46, wherein the reference is non-reflective.

53. The apparatus according to claim 46, wherein a median of the spectrum varies substantially linearly over time.

54. The apparatus according to claim 46, wherein the at least one first arrangement includes a spectral filter to vary the spectrum over time.

55. The apparatus according to claim 54, wherein the spectral filter includes a polygon scanner and a spectral separating arrangement that vary the spectrum over time.

56. The apparatus according to claim 46, wherein the at least one first arrangement includes a semiconductor gain medium at least one of generating and amplifying an electro-magnetic radiation.

57. The apparatus according to claim 46, further comprising at least one fourth arrangement generating an image based on the detected interference, wherein the first and second polarization states are approximately orthogonal to one another.

58. The apparatus according to claim 48, wherein at least one second arrangement comprises at least one photodetector and at least one electrical filter which follows the at least one photodetector.

59. The apparatus according to claim 58, wherein the at least one electric filter is a bandpass filter having a center frequency that is approximately the same as a magnitude of the frequency shift by the frequency shifting arrangement.

60. The apparatus according to claim 59, wherein a transmission profile of the electrical filter varies substantially over its passband.

61. The apparatus according to claim 50, wherein the probe comprises a rotary junction and a fiber-optic catheter.

62. The apparatus according to claim 46, wherein the catheter is rotated at a speed higher than 30 revolutions per second.

63. The apparatus according to claim 46, further comprising at least one polarization modulator.

64. The apparatus according to claim 46, wherein the at least one second arrangement is capable of detecting a polarization state of at least one of the first and second electromagnetic radiation.

65. The apparatus according to claim 46, wherein the at least one second arrangement comprises at least one dual balanced receiver.

66. The apparatus according to claim 46, wherein the at least one second arrangement comprises at least one polarization diverse receiver.

67. The apparatus according to claim 46, wherein the at least one second arrangement comprises at least one polarization diverse and dual balanced receiver.

68. The apparatus according to claim 46, further comprising at least one third arrangement for tracking the phase difference between at least one of:

- the at least one first electromagnetic radiation and the at least one second electromagnetic radiation, and
- the at least one third electromagnetic radiation and the at least one fourth electromagnetic radiation.

69. A method comprising the steps of:

providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a reference, wherein a frequency of the at least one of the first and second radiations varies over time;

detecting a first interference signal between at least one third radiation associated with the at least one first radiation and at least one fourth radiation associated with the at least one second radiation in a first polarization state; and

detecting a second interference signal between the third and fourth electro-magnetic radiations in a second polarization state, wherein the first and second polarization states being different from one another.

70. The method according to claim 69, wherein the at least one third radiation is a radiation returned from the sample, and the at least one fourth radiation is a radiation returned from the reference.

71. An apparatus comprising:

at least one first arrangement providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a reference, wherein at least one of the first and second electro-magnetic radiations has a spectrum whose mean frequency changes substantially continuously over time at a tuning speed that is greater than 100 Tera Hertz per millisecond; and

at least one second arrangement detecting an interference between at least one third radiation associated with the at least one first radiation and at least one fourth radiation associated with the at least one second radiation.

72. The apparatus according to claim 71, wherein the mean frequency changes repeatedly at a repetition rate that is greater than 5 kilo Hertz.

73. The apparatus according to claim 71, wherein the mean frequency changes over a range that is greater than 10 Tera Hertz.

74. The apparatus according to claim 71, wherein the spectrum has an instantaneous line width that is smaller than 100 Giga Hertz.

75. The apparatus according to claim 71, further comprising a laser cavity with a roundtrip length shorter than 5 m.

76. The apparatus according to claim 73, the center of the tuning range of the spectrum is nominally centered at 1300 nm.

77. The apparatus according to claim 73, the center of the tuning range of the spectrum is nominally centered at 850 nm.

78. The apparatus according to claim 73, the center of the tuning range of the spectrum is nominally centered at 1700 nm.

79. A method comprising the steps of:

providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a reference, wherein at least one of the first and second electro-magnetic radiations has a spectrum whose mean frequency changes substantially continuously over time at a tuning speed that is greater than 100 Tera Hertz per millisecond; and

detecting an interference between at least one third radiation associated with the at least one first radiation and at least one fourth radiation associated with the at least one second radiation.

80. An apparatus comprising:

at least one first arrangement providing at least one first electro-magnetic radiation to a sample and at least one second electro-magnetic radiation to a reference, wherein a frequency of radiation provided by the at least one first arrangement varies over time;

at least one second arrangement adapted for shifting the frequency of the at least one first electro-magnetic radiation and the at least one second electromagnetic radiation;

an interferometer interfering the first and second electro-magnetic radiations to produce an interference signal; and

at least one second arrangement detecting the interference between the first and second electro-magnetic radiations.

81. A system for determining particular data associated with at least one of a structure and composition of a tissue, comprising:

a processing arrangement, which when executing a predetermined technique, is configured to:

a) receive information associated with an interferometric signal which is formed from at least one first electro-magnetic radiation obtained from a

sample and at least one second electro-magnetic radiation obtained from a reference, wherein at least one of the first and second electro-magnetic radiations is frequency-shifted,

b) sample the information to generate sampled data in a first format, and

c) transform the sampled data into the particular data that is in a second format, the first and second format being different from one another.

82. The system according to claim 81, wherein the second format has at least two sampling intervals representing substantially the same electro-magnetic frequency difference.

83. The system according to claim 82, wherein each of the sampling intervals represents substantially the same electro-magnetic frequency difference.

84. The system according to claim 81, wherein procedure (c) includes interpolating the sampled data.

85. The systems according to claim 84, wherein at least one of the first and second electro-magnetic radiations is frequency-shifted by a particular frequency, and wherein the interpolation includes Fourier transforming the sampled data into an array in a frequency domain and separating the array into at least two frequency bands based on the particular frequency.

86. The system according to claim 85, wherein the interpolation includes Fourier transforming the sampled data into an array in a frequency domain, and increasing a size of the array and inserting a predetermined value into each element of an increased portion of the array.

87. The system according to claim 81, wherein the processing arrangement is further configured to generate an image of at least one portion of the tissue based on the particular data.

88. The system according to claim 87, wherein the image has a particular resolution, wherein a spectrum of electro-magnetic frequencies associated with the sampled data relates to the particular resolution, and wherein the particular resolution is substantially proximal to a Fourier Transform limit of the spectrum of the electro-magnetic frequencies.

89. The system according to claim 85, wherein the second format has at least two sampling intervals representing substantially the same electro-magnetic frequency difference, and wherein a magnitude of the particular frequency is greater than approximately a quarter of a reciprocal of at least one of the sampling intervals.

90. The system according to claim 87, wherein the second format is an image format, and wherein the image is based on the transformed sampled data.

91. The system according to claim 84, wherein the second format is a format that includes approximately constant k-space intervals.

92. A method for determining particular data associated with at least one of a structure and composition of a tissue, comprising the steps:

receiving information associated with an interferometric signal which is formed from at least one first electro-magnetic radiation obtained from a sample and at least one second electro-magnetic radiation obtained from a reference, wherein at least one of the first and second electro-magnetic radiations is frequency-shifted;

sampling the information to generate sampled data in a first format; and

transforming the sampled data into the particular data that is in a second format, the first and second format being different from one another.

93. Storage medium for determining particular data associated with at least one of a structure and composition of a tissue, the storage medium maintaining a program thereon which, when executed by a processing arrangement is configured to perform instructions comprising::

receiving information associated with an interferometric signal which is formed from at least one first electro-magnetic radiation obtained from a sample and

at least one second electro-magnetic radiation obtained from a reference, wherein at least one of the first and second electro-magnetic radiations is frequency-shifted;

sampling the information to generate sampled data in a first format; and

transforming the sampled data into the particular data that is in a second format, the first and second format being different from one another.